DOCUMENT RESUME

ED 106 147 SE 019 169

AUTHOR Walker, Alice A.
TITLE The Development of Semantic Components of Number.
PUB DATE Mar 75
NOTE 9p.; Paper presented at the annual meeting of the American Educational Research Association (Washington, D. C., March 30 - April 3, 1975)

EDRS PRICE MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS *Cognitive Development; Conservation (Concept); Early Childhood Education; Learning; Linguistic Competence; *Literature Reviews; Mathematical Vocabulary; *Mathematics Education; *Number Concepts; *Research
IDENTIFIERS *Piaget (Jean)

ABSTRACT

In this paper the author reviews and synthesizes the research literature concerning the developmental relationships between conservation of number and linguistic capability in handling of quantitative and relational terms. Several models for the development of these competencies are discussed. On the basis of this review the author concludes that linguistic mastery of relational concepts and comparison generally coincides with the appearance of conservation, and therefore, that "the development of comparative language is an essential component of the development of number concepts." (SD)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

ED106147

THE DEVELOPMENT OF SEMANTIC COMPONENTS OF NUMBER

Alice A. Walker
SUNY, College at Cortland

The development of relational concepts or the use of comparative language is inextricably bound up with the development of number concepts. Generally, the ability to conserve is considered a manifestation of a reasonably well-developed concept of number. Several studies have shown that children who conserve demonstrate a greater degree of competence in the use of relational concepts (Palermo, 1973; Sinclair-de-Zwart, 1969; Harasym, Boersma, and Maguire, 1971).

Sinclair-de-Zwart (1969) examined the relationship between linguistic development and conservation. She found that children with conservation used comparatives 90 to 100 percent of the time in describing materials while children without conservation used absolute terms most of the time. Sinclair-de-Zwart then attempted to teach the non-conservers comparative language. She found that it was difficult to teach children "more" and "less" and even more difficult to get them to utilize coordinated comparatives. Sinclaire-de-Zwart, as well as Inhelder et.al. (1966), concluded that acquisition of relational concepts parallels the development of operational structuring and is important in the development of cognitive structures such as number concepts. Others, such as Peisach (1973) and Walker (1974), have also shown that use of relational concepts is a necessary prerequisite of conservation.

Bingham-Newman and Hooper (1974) recently conducted a study looking at the effects of training on classification and seriation tasks on the overall cognitive development of the child and, in particular, on transfer to conservation tasks. Bingham-Newman and Hooper found that the most effective training condition was the seriation tasks which began with teaching the child comparison between two sizes and

SE019 169

then went on to more advanced uses of relational concepts, ultimately leading to training on one-to-one correspondence and multiple seriation. Bingham-Newman and Hooper concluded that the mastery of relational concepts precedes that of class concepts in a manner analogous to seriation preceding coordination.

The most elementary quantitative concept would seem to be that of a simple magnitude discrimination, that is, recognition that there is "more" in one collection or group than another or that one object is "bigger" than another. Such a task would seem to involve mere recognition of a quantitative difference, with the size of the difference being irrelevant.

However, for a young child such a task is not as simple as it sounds. Such tasks require the understanding and use of relational concepts and comparative language. Moreover, a child must have a fairly well-developed understanding of comparative language concepts in order to deal effectively with tasks in which comparative relationships play an integral part, such as the Piagetian conservation tasks.

While a child may be using terms such as "more" and bigger" at two and three years of age, it is generally much later before the child demonstrates that he has a well-defined quantitative concept for "more" that can be used in a variety of situations.

Among the first to look carefully at the development of comparison in children were Wales and Campbell (1970). They looked at the development of antonymic pairs of comparative adjectives such as "short-long" and "fat-thin" in three and four-year-old children. In all such pairs, one of the members is less restricted in distribution than the other, that is, it has a positive value. The less restricted, or unmarked, member of such pairs was found to be used correctly by children earlier than its antonym. Wales and Campbell, on the basis of their results as well as those

obtained by Donaldson and Wales (1970), proposed the following model for the development of relational concepts. First the unmarked member is learned, for example, "more." The marked member, in this case, "less," is initially treated as synonymous with its antonym. Only later does the child come to differentiate the pair correctly. Wales and Campbell also found this to be the case in differentiating superlatives and comparatives. First, the superlative is learned as a simple two-place comparison. When the comparative is learned, it is used for the same type and range of comparisons as the superlatives. Finally, a third stage is reached where the usage of comparatives and superlatives is correctly differentiated.

This progression from synonymity to differentiation was clearly demonstrated by Donaldson and Balfour (1968) for the pair "more-less." They placed before their subjects, who ranged in age from 3 1/2 to 4 years old, two cardboard apple trees with hooks on which apples could be hung. The subjects were asked questions about eight different stimulus situations. For example, the subject was shown two blank trees and asked to put more apples on one tree than the other. In another situation, the subject was shown the trees with an equal number of apples on each and the experimenter would say, "If I put this apple on this tree, will one of the trees have more apples than the other?" A similar set of tasks was presented using "less" instead of "more." The most consistent finding Donaldson and Balfour obtained was that in the majority of cases the responses did not indicate that children were differentiating "more" from "less" but were, instead, treating them synonymously.

Several other investigators have subsequently looked at the development of "more" and "less" and obtained essentially the same results. Harasym, Boersma, and Maguire (1971) used the semantic differential to evaluate children's meanings for "more" and "less." They grouped children on the basis of conservation ability

on the assumption that conservers would be capable of finer quantitative descriminations. The results did indeed support their hypothesis that conservers had a greater understanding of relational terms with much better differentiation of the poles of the antonymic relationships.

Palermo (1973) replicated the Donaldson and Balfour task with the apple trees and added a second similar task using water. His findings supported Donaldson and Balfour as he, too, found that children in the age range of three to four years old who did not know "less" consistently responded as if "less" meant "more." Moreover, he did a second study with older children and found that even among seven-year-olds there were some who still had not differentiated "more" and "less." Palermo also used the semantic differential with the older children and the data from this task provided further corroboration that children who didn't know "less" treated it as synonymous with "more."

Wales and Campbell (1970) also showed that pairs, such as "more-less," don't develop in isolation but rather that there is a concomitant development across many such pairs. Consequently, a child is developing not only an understanding of "more" and "less," but also of "fat-thin," "long-short," and other such pairs at the same time, all of which contribute to an understanding of quantitative differences. These pairs of adjectives also showed differential learning on the part of children with the unmarked member being learned first. Townsend (1974) also obtained similar results for relational adjectives.

Herbert Clark (1970) in reviewing the work of Donaldson, Wales, Campbell, and Balfour, as well as some of his own work with adults, has arrived at the following explanation for the development of comparatives in young children. In pairs of relational adjectives, the unmarked member usually indicates the presence of an attribute. For example, in the pair "short-long," "long" indicates the presence of an attribute,

length, and "short" indicates its absence. However, "long" can be used in two ways--what Clark calls a nominal use and a contrastive use. An example of a nominal use would be to describe a board as ten feet "long." Here "long" is used merely to indicate the presence of length. "Long," of course, can also be used in a comparative sense, as "one board is longer than another." However, we never use "short" in a nominal sense. We never speak of a board or pole as being "two feet short" or of an individual as being "six feet short." In all such cases, the unmarked member indicates extension, as in the dimensions for length, depth, and width.

Clark posits the following developmental sequence for the development of "more-less" and other such pairs. Initially, the child uses "more" and "less" in the nominal, noncomparative sense. Since the nominal term refers to extension or the presence of an attribute, the child uses these terms to indicate extension. In this first stage, "more" is used as if it means "some" or a "quantity of" and when a child says, "I want more cookies." He is using "more" to mean "some cookies" or an "additional amount of cookies" rather than as a comparative. The child at this stage also interprets "less: as meaning "some." Consequently, when a child at this stage is asked to choose among two sizes of object, he chooses the one having the most extent because it best exemplifies the situation of "having some."

It is not until the final stage that the child learns to use the terms in a true comparative sense. The child learns to attend to two objects at the same time, and to compare them to decide which has the lower or higher measure of extent. It is only then that the child demonstrates a true understanding and use of relational terms, a use which requires the child to have rather complex linguistic or semantic structures.

There has been some conjecture in the literature that the differences in the acquisition of polar adjectives may be due to differences in the frequency of usage of

the positive terms, particularly among adult models, rather than due to the linguistic characteristics of relational terms that were pointed out by Clark. Klatzky, Clark, and Macken (1973) attempted to sort out these effects in a study in which nonsense syllables were used as substitutes for relational terms. If Herbert Clark's thesis is correct, then children should learn the nonsense syllables representing the positive pole faster than its opposite. They presented to children, who ranged in age from 3 years, 7 months to 4 years, 11 months, sets of stimuli representing the dimensions of size, height, length and thickness. These dimensions could be described by the pairs: big-small, high-low, long-short, and thick-thin. Nonsense syllables were substituted for these pairs and the children were given a series of learning trials to see if they acquired the nonsense syllables representing these relationships asymmetrically. The results did corroborate the hypothesis that children learn the positive, or unmarked member, more easily, and that it is not an artifact of adult usage.

In the development of relational concepts, then, a child passes through several stages. First, he uses relational terms in a nominal sense, that is, as acknowledging the existence or presence of an attribute--in quantitative situations this would be the recognition that an object has extension. Having recognized the existence of extension, the child then uses the polar adjectives interchangeably as indicators of extension. It is only in the last stage that the child uses the adjectives in a true comparative or contrastive sense.

The mastery of relational concepts and comparison usually seems to correspond with the appearance of conservation, thus underscoring the parallel development of linguistic structures and general cognitive-mathematical growth. It would seem warranted, therefore, to conclude that the development of comparative language is an essential component in the development of number concepts.

REFERENCES

Bingham-Newman, A.M., and Hooper, F.H. Classification and seriation instruction and logical task performance in the preschool. American Educational Research Journal, 1974, 11, 379-393.

Donaldson, Margaret, and Balfour, G. Less is more: A study of language comprehension in children. British Journal of Psychology, 1968, 59, 461-471.

Donaldson, Margaret and Wales, Roger J. On the acquisition of some relational terms. In Hayes, John R. (Ed.), Cognition and the development of language. New York: John Wiley and Sons, Inc., 1970, pp. 235-268.

Harasym, Carolyn, Boersma, F.J., and Maguire, T.O. Semantic differential analysis relational terms used in conservation. Child Development, 1971, 42, 767-779.

Inhelder, B., Bovet, M., Sinclair, H., and Smock, C.T. On cognitive development. American Psychologist, 1966, 21, 160-164.

Katzy, R.L., Clark, E.V., and Macken, M. Asymmetries in the acquisition of polar adjectives: Linguistic or conceptual? Journal of Experimental Child Psychology, 1973, 16, 32-46.

Peisach, Estelle. Relationship between knowledge and use of dimensional language and achievement of conservation. Developmental Psychology, 1973, 9, 189-197.

Sinclair-de-Zwart, Hermina. Developmental Psycholinguistics. In Elkind, D. and Flavel, John (Eds.) Studies in cognitive development. New York: Oxford University Press, 1969.

Townsend, David J. Children's Comprehension of Comparative Forms. Journal of Experimental Child Psychology, 1974, 18, 293-303.

Wales, Roger, and Campbell, Robin. On the development of comparison and the comparison of development. In d'Arcais, G.B. and Levett, W.J.M. Advances in

Psycholinguistics. Amsterdam: North Holland Pub. Co., 1970. pp. 373-396.

Walker, A.A. A developmental sequence of skills leading to conservation. Unpublished doctoral dissertation.